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Historicity of Celestial Observations of Mahābhārata

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Abstract

Mahābhārata contains references to several eclipses and planetary positions. Whether or not these textual statements represent real historical observations made by our ancients is of considerable scientific interest. It is unlikely that later reciters and copyists of the epic would have tampered with descriptions of natural phenomena like eclipses, even though transcription and transmission errors cannot be ruled out. Scientific investigation and dating of such celestial observations may also help in resolving some issues connected with the historicity of Mahābhārata. Planetarium softwares are powerful tools for computer investigation of thousands of possibilities and for sifting through obscure texts on celestial events. Such an exercise in archaeo-astronomy leads us to the conclusion that the eclipses and planetary observations of Mahābhārata belong to the period 1493BC-1443BC of Indian history.

Introduction

The great epic Mahābhārata (MB for short) is believed to be historical by a vast majority of people in India. Tradition attributes the authorship of the epic with a hundred thousand verses to Kŗşņa Dvaipāyana, popularly known as Veda-vyāsa. However there are sufficient reasons to believe that the epic grew to its present form from a smaller epic called Bhārata, which in turn developed out of the poem Jaya with only 8800 verses. It is not clear when for the first time the text of the epic was written down in script form. However it is known that the acclaimed poet, Bhāsa (*circa* 2nd cent. BC) wrote six dramas[1] inspired by MB. Thus, the nucleus of MB should belong to an ancient period of Indian history carried up to a point in time through oral traditions. Such traditions had regional differences leading to further variations. Superposed on such oral versions arose, at later times, inconsistencies and errors in writing and copying. Some of these might have been intentionally done to highlight particular religious beliefs. However, not withstanding such difficulties, it is expected that descriptions of natural phenomenon such as an evening sky or a flood or an earthquake would not have been distorted intentionally. Similar would be the case, after due allowances are made for a poetic language, with planetary positions and observation of eclipses. MB contains descriptions of several celestial phenomena as the story unfolds. It would be interesting to verify whether these descriptions are internally consistent or not. A fair degree of consistency, among the various statements available in the text, is a prerequisite for them to be treated as real observations, worthy of being taken as historical facts. As far as celestial observations are concerned, the test for consistency would mean arriving at one or more possible past dates, for the events, by back calculations. Since this would be a scientific and hence a less controversial approach to date MB, several persons have searched for astronomical references in the text. The major limitation of past studies has been that they do not show how to reconcile inconsistencies such as *śanaiścara* (Saturn) being said to be with star *Rohiṇỉ* (Aldebaran) as well as being near star *Viśakha* (α-Librae) as stated in the *bhỉṣma parvan* of the epic. Dikshit in his famous work on History of Indian Astronomy (1896) first noticed such inconsistencies. This motion of Saturn in the span of a few days or weeks is impossible. Perhaps, this has lead some persons to discard all astronomical information available in the MB text as unreliable. An excellent discussion on the historicity of MB including differing views based on astronomical calculations is available in a book edited by Gupta and Ramachandran (1976). This book is available in full at the web site (http://abob.libs.uga.edu/bobk/maha/). Difficulties involved in understanding the archaic text has lead some scholars to take the easy approach of interpreting a few simple statements to propose dates, thousands of years apart. In the absence of computers for back calculations, results found with one or two constraints are not reliable. The only rigorous study to investigate the planetary configurations and eclipses using modern astronomical almanacs and computers has been by Sharma (1986). He proposes that some of the inconsistencies encountered in the epic could be accounted for, if the conversation between Vyāsa and Dhrtarāṣṭra in *bhỉṣma parvan* is assumed to have taken place on different dates within the same year. His analysis leads to 1493 BC and 2109 BC as two possible years for the MB war. His study does not account for all the eclipses and planetary positions in the text. The present author (Iyengar 2003) investigated this issue afresh covering the period of 501BC-3000BC to see whether astronomical statements provided in the different parts (*parvans*) of the epic are compatible among themselves or not. In the present paper the anterior limit is extended to 3250 BC to cover the traditional date of 3102 BC for the start of Kaliyuga. The study is based on interpreting the original Sanskrit text and extensive application of modern planetarium softwares. For this purpose, five different versions of the original epic have been consulted. The first is the edition of Bhandarkar Oriental Research Institute, Pune that is available on the web site (http://home.dongguk.edu/user/india/text/e-mbh.htm)[2]. The second is the edition brought out by Purāṇam Hayagrỉva Śāstri in Telugu script in 1850-60[3]. The edition brought out by Gita Press of Gorakhpur, with the 17th century commentary of Nỉlakaṇṭha also has been referred for planetary positions of *bhỉṣma parvan*. The 19th century line by line English translation of Kisari Mohan Ganguly[4] and Bhārata-darśana, a Kannada version of the epic, by a team of scholars[5] have also been consulted.

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[1] Superscripts and numbers in parentheses refer to notes and references at the end of the text.

Approach of Study

The procedure adopted for the present investigation may be described in five steps.

i) Almanac related informations available in the text are briefly reviewed. The effort has been to highlight what is relevant in marking relative and hopefully absolute time frame of some important events. All the original Sanskrit text used is reproduced along with its brief meaning. Chapter and verse numbers refer to the second version of the text cited above. Differences between the various versions are discussed wherever necessary.

ii) The long period of 3250 BC–501 BC is searched with the help of modern planetarium and eclipse softwares to prepare a candidate list of possible years for the war as per the most reliable part of the text in *bhỉṣma parvan.*

iii) Dates compatible with the occurrence of an eclipse at Dvārakā in the 36th year reckoned from the Great War are identified, as per the text in *mausala parvan*.

iv) Possible solar eclipses 13-15 years prior to the one in the war year are found as per the text in *sabhā parvan.*

v) All the above triplets of years are further matched with the most reliable planetary positions as per the text in *udyoga parvan* for further discussion and conclusions.

Background Information

At the very beginning in the second chapter of the first book, verse thirteen reads

antare caiva sampāapte kali-dvāparayoh abhūt
samanta-pańcake yuddham kuru-pāņđava-senayoh (adi.p. 2.13)

The war between the armies of Kurus and Pandavas took place at samanta pańcaka during the transition between kali-yuga and dvāpara-yuga.

In the absence of other independent statements within the text regarding the beginning of *kali-yuga*, the above verse is not of any help in fixing a date for the war. There are several references to *tithi* (moon's phase) and *nakşatra* (star), which can fix a day or night within a given year. For example, when the young Pāņđavās were coaxed to go to Vāraņāvata

Aşţame ahani rohiņyām prayātā phālguņasya te (ādi.p.145.34)

They traveled on the eighth day of phālguņa month, under star rohiņỉ.

The *nakşatra* was decided based on the position of moon, which is explicitly stated, as when Vyāsa advises Yudhişţhira regarding his marriage

adya pauşyam yogam upaiti candramāħ (ādi.p. 198.5)

Today moon will attain the yoga of star puşya.

Specific details are given some times, like when Bhỉma fights Jarāsandha. It is said that the fight started on the first day of the *kārtika* month and ended on the fourteenth day (*sab.p*. 24.28-30). The months should have been lunar, ending with full moon. This is clear from the nomenclatures, *ardha-māsa* and *pūrņa-māsi* for new-moon and full-moon respectively. Month names appear in several places, but year names are conspicuously absent like week names. When Vyāsa visits Yudhişţhira after the Rājasūya yāga, the king refers to three types of (terrestrial, atmospheric and celestial) bad signs (*utpāta*) mentioned by Nārada and asks whether the killing of Śiśupāla was one of them. Vyāsa just says

Trayodaśa ***samāħ*** *rājan utpātānām phalam mahat (sab.p. 46.11)*

Oh, king these bad omens bear fruit in thirteen years.

It is not mentioned how the years were counted; except for a hint in *sabhā parvan* (ch.75 v.11-12) where *vatsara,* and *parivatsara* are also used in the sense of years. Later in a few places*, samvatsara* is also used. Hence, in all probability, the five-year cycle of *Vedāňga-jyotişa* was in vogue and the *Vaidika-sāvana* year with 360 days was used for the civil calendar. This has been asserted to be so by the commentator Nỉlakaņţha, while accounting for the thirteen-year exile of Pāņđavas, when Arjuna reveals himself on the *aşţamỉ-tithi* of a month surmised to be *āşāđha* (*vir.p*. ch. 52) in the summer season. The seasons are mentioned indirectly, as in

Tānyanỉkānyadŗśyanta kurūņām ugradhanvinām
Samsarpante yadā meghāħ gharmānte mandamārutaiħ (vir.p. 56.1)

The armies of the Kurus were seen between the end of summer and the beginning of the rainy season.

Kaumude māsi revatyām śaradante himāgame (udy.p. 82.7)

Kŗşņa set out on his mediation effort at the end of autumn with dew starting, in the month of kārtikā under star revatỉ.

Kŗşņa describes the onset of the cool season to Karņa, as

Saumyoyam vartate māsah suprāpah yavasendhanaħ
Pakvoşadhi-vanasphỉtah phalavān alpamakşikaħ
Nişpaňko rasavattoyo nātyuşņa-śiśirah sukhaħ
Saptamācchāpi divasāt amāvāsyā bhavişyati
Sangrāmam yojayet tatra tamāhuħ śakradevatam (udy.p.140.16-18)

This month is mild, with easily procured cereals and fuel. Forests are with ripe fruits and medicinal plants and with not too many flies. Water is tasty without dirt. This season is not too hot but pleasant. Seventh day from today is the new moon, important for god Indra. Let the battle be planned for that day.

Eclipses

Mahabharata proposes a rudimentary theory of eclipses. In *bhỉşma parvan (12.40-12.47)* before the start of the war, Sanjaya states that the diameter of Rāhu is 12,000 yojanas, whereas the diameters of Moon and Sun are 11,000 and 10,000 yojanas respectively. The circumference of Rāhu, Moon and Sun works out to be 36000, 33000 and 30000 yojanas respectively. Hence, being bigger, Rāhu at appropriate times covers (*chādayati*) Moon and Sun. These statements are interesting in that a physical reason is given for eclipses instead of the usual mythological stories. This also provides the reason for referring Rāhu as *mahāgraha*, the big planet.

There are eight places in the text where solar eclipses (S.E.) are mentioned, but not all of them are credible as actual observations. Three eclipses are of prime importance in the story line of the epic. The first is in *sabhā parvan* after Pāņđavas are banished to the forest. In answer to a question on how Pāņđavas started their journey, Vidura gives a graphic description of the various events and incidentally mentions

Anabhre vidyutaścāsan bhūmiśca samakampatā
Rāhuragrasadādityam aparvaņi viśāmpate (sab.p. 79.29)

In the cloudless sky there were lightnings; the earth shook and Rāhu caught the sun, but, not on the fifteenth day.

Several portents are described in the text starting with the Rājasūya sacrifice and ending with the gambling episode. Hence the above eclipse might not have been exactly at the time of Pāņđavas leaving Hastināpura. Dhŗtarāşţra confirms this eclipse much later as he broods over the sad happenings, in the last chapter of *sabhā parvan;*

Divā ulkāħ patantyaśca rāhuścārkam upāgrasat
Aparvaņi mahāghoram prajānām sanjanayan bhayam (sab.p.80.23)

Meteorites are falling in daytime, and Rāhu covered Sun on an odd day causing great fear among people.

The place of observation of this eclipse was Hastināpura not far away from Kurukşetra. The second mention of a S.E is in *udyoga parvan* when Karņa tells Kŗşņa

Somasya lakşma vyāvŗttam arkam rāhuħ upaişyati (udy.p. 142.11)

Brightness of Moon is covered up and Rāhu is approaching Sun.

This is not an observation of an eclipse but only an expectation. The alternate reading of this verse is similar, the last word being replaced by *upaiti ca.* The text is very clear that the conversation between Kŗşņa and Karņa (quoted previously, *udy.p.*140.16-18) took place a week before a new moon. Hence the above cannot be a direct observation. This can at best be an observation before the month of *kārtika* in the same year. This should be same as the solar eclipse of *bhỉşma parvan* chapter 3 when Vyāsa tells Dhŗtarāşţra

Abhỉkşņam kampate bhūmiħ arkam rāhuħ tathāgrasat (bhi.p. 3.11)

The earth shakes often, similarly Rāhu caught up Sun (often?).

After three sentences, all versions refer to *mahāgraha*, that is Rāhu.

Senayoh aśivam ghoram karişyati mahāgrahaħ (bhi.p. 3.13)

Rāhu does bad to both the armies.

Thus some time before the war all versions indicate occurrence of a solar eclipse. But a difficulty arises due to the mention of another eclipse a few verses later in the same chapter. This is a solar eclipse stated along with a lunar eclipse in the same month as,

Candra-suryāvubhau grastau eka māse trayodśīm (bhī.p. 3.29)

Moon and Sun were eclipsed in the same month at thirteen days (interval).

This eclipse will be discussed in detail later in this study. An eclipse is alluded to in *śalya parvan,* on the last day of the war, before the dual between Bhīma and Duryodhana. Among the several bad omens an eclipse finds mention as

Rāhuśca agrasad ādityam aparvaņi viśāmpate
Cakampe ca mahākampam prithivī sa-vana-drumā (śal.p. 56.10)

Rāhu caught up Sun at an odd time. The earth shook along with trees and forests.

All the editions carry this verse. However this event is not credible as an eclipse. This follows from the previous statements in *bhīşma parvan*, that the eighteen-day war started the day next to a *kārtika* full moon. The final solar eclipse reliably cited is in *mausala parvan*, in the thirty-sixth year after the war;

Caturdaśī paňcadaśī kŗteyam rāhuņā punaħ
Mene prāptam sa-śat-trimśam varşamvai keśisūdanaħ (mau.p. 2.19, 2.20)

The fourteenth day has been made into the fifteenth again by Rāhu. Kŗşņa understood that the 36th year (as said by Gāndharī at the end of the MB war) had arrived.

This eclipse is mentioned in all the editions of the text. Also this event finds prominent mention, in the Prabhāsa Khāņđa of Skānda Purāņa, while describing the last days of Kŗşņa. In contrast with solar eclipses, mention of lunar eclipses is almost absent. In *udyoga parvan,* Karņa during his conversation with Kŗşņa mentions *somasya lakşma vyāvŗttam*, (*udy.p.*141.10) meaning light of the moon is circumscribed. In *bhīşma parvan* during his discourse Vyāsa says

Alakşyaħ prabhayā hīnaħ paurņamāsīňca kārtikīm
Candro abhūdagnivarņaħ padma-varņe nabhasthale (bhī.p. 2.23)

This is a poetic reference to the *kārtika* full moon becoming invisible and devoid of light, but turning fiery in the lotus coloured sky. It is not clear from the above descriptions whether an eclipse is meant, or just an optical anomaly. The only unambiguous lunar eclipse is the one associated with a solar eclipse in the same month, already mentioned above.

Planetary Positions

Positions of planets are described in the text with reference to their nearness to fixed stars. Since these statements are needed for our later discussion here the text and a simple working translation, with a number, are provided. The first statement about planetary positions occurs in *udyoga parvan*, when Karṇa and Kṛşṇa are conversing.

Prājāpatyam hi nakşatram grahahstỉkşṇo mahādyutiħ
śanaiścaraħ pỉđayati pỉđayan prāṇinodhikam
Kṛtvā ca angārako vakram jyeşṭhāyām madhusūdana
Anūrādhām prārthayate maitram samśamayanniva
Nūnam mahadbhayam kṛşṇa kurūṇām samupasthitham
Viśeşeṇa hi vārşṇeya citrām pỉđayate grahaħ (udy.p. 142.8-142.10)

Saturn is near star Rohiṇỉ. Mars, having been retrograde, is requesting Anūrādha (as if doubting the friendship) from Jyeşṭha. There is a planet near Citrā. *(p.p.1)*

In *bhỉşma parvan* a series of planetary positions are given, some of which are apparently incompatible. In chapter 2, Vyāsa in conversation with Dhṛtarāşṭra mentions,

Rohiṇỉm pỉđayanneşa sthito rājā śanaiścaraħ (bhi.p.2.32)

Saturn is staying near Rohiṇỉ. *(p.p.2)*

In the next chapter, again it is said,

śveto grahaħ tathā citrām samatikramya tişṭhati (bhi.p.3.11)

A white planet resides, having crossed Citrā. (p.p.3)

These two are in conformity with the earlier text (p.p.1) in *udyoga parvan.* However, after three lines not connected with planetary positions, Vyāsa is supposed to say again,

Maghāsvangārako vakraħ śravaṇeca bṛhaspatiħ
Bhagam nakşatram ākramya sūryaputreṇa pỉđyate
śukraħ proşṭhapade pūrve samāruhya viśāmpate
Uttare tu parikramya sahitah pratyudỉkşate
śyāmo grahaħ prajvalitaħ sadhūmaħ saha pāvakaħ
Aindram tejasvỉ nakşatram jyeşṭhām ākramya tişṭhati
Dhruvah prajvalito ghoram apasavyam pravartate
Citrā-svāti antarecaiva dhişṭitah paruşo grahaħ
Vakrānuvakram kṛtvā ca śravaṇe pāvakaprabhaħ
Brahma-rāśim samāvṛtya lohitāngo vyavasthitaħ (bhi.p.3.14-3.19)

Mars, in retrograde, is in Maghā. Jupiter is in S'ravaṇa. Sūrya-putra (son of Sun) is afflicting Pūrva-phalgunỉ. S'ukra (literally one who is white, Venus) previously getting up in star Pūrvābhādra and having circled in North (or star Uttarābhādra or star

Uttarā) is looking up, with a company. The dark planet blazing with smoke and fire is with Jyeşţha. Brightened Dhruva (pole star) is positioning itself anti-clockwise. A rough planet is seen between Citrā and Svātỉ. The fire coloured planet is in S'ravaņa, after being retrograde. The red-bodied planet is in Brahma-rāśi. *(p.p.4)*

In the above if Sūrya-putra is taken as Saturn, as is traditionally done, then the previous position of Saturn remains contradicted. About Mars, also it is ambiguous. The position of Venus is given as being near Pūrvābhādra. However, its described motion can be interpreted in three different ways. The last two lines of the text are not clear as to what planets were meant by the poet. Traditionally this verse is taken to indicate the position of Mars. The word *lohitāňga* (red-bodied) may indicate Mars. However, the word *pāvakaprabhaħ* (fire-coloured) may not necessarily refer again to Mars, since the location of *śravaņa*, was assigned previously to Jupiter. An extra observation *'Rohiņỉm piđayatyevam ubhauca śaśi-bhāskarau'* is also available in some versions. Some editions read 'Bhagam' in the second line above as 'Bhāgyam'. Similarly, in the fifth line, 'śyāmo grahah' is read as 'śveto grahah'. In all editions, after another six verses a few more positions are stated.

Grahau tāmrāruņa-śikhau prajvalntāviva sthitau
Saptaŗśỉņām udārāņām samavacchādya vai prabhām
Samvatsara-sthāyinauca grahau prajvalitāvubhau
Viśākhayoh samỉpasthau bŗhaspati-śanaiścarau
Kŗttikāsu grahahstỉvrah nakşatre prathame jvalan
Vapūmşi apaharan bhāsā dhūmaketuriva sthitaħ
Trişu pūrveşu sarveşu nakşatreşu viśāmpate
Budhah sampatate abhikşņam janayan su-mahadbhayam
Caturdaśỉm paňcadaśỉm bhūtapurvāňca şođaśỉm
Imāmtu nābhijānāmi amāvāsyām trayodaśỉm
Candra-sūryāvubhau grastau eka-māse trayodaśỉm
Aparvaņi grahāvetau prajā-samkşapayişyataħ *(bhỉ.p. 3.23-3.29)*

Two blazing planets have reduced the brightness of Saptaŗşi (Ursa Major). Jupiter and Saturn being stationary for a year are near (the double stars) Viśākha. There is a sharp planet with the first star of kŗttikā, like a comet. In the three stars preceding this, Mercury is seen often. I know instances of amāvāsya falling on the fourteenth, fifteenth and sixteenth day of the fortnight, but not on the thirteenth day like now. Moon and Sun both got eclipsed in the same month, oddly at thirteen days (interval). *(p.p.5)*

In this position also, there are variant readings. The Gita Press edition gives an extra eclipse statement after the fourth line

Candrādityau ubhau grastau ekāhna hi trayodaśỉm
Aparvaņi graham yātau prajā-samkşayam icchataħ

Nîlakaṇṭha explains this as a solar eclipse on the thirteenth day, highlighting the occurrence of a fortnight short by two days, which is unusual. Another glaring difference in this version is the substitution of *budha (Mercury)* by *gṛdhra (eagle)* in the eighth line.

A few other passing references to planets are,

Hatesma karṇo sarito na sravanti jagāma cāsto kaluṣo divākarah
Grahaśca tiryak jvalitārka-varṇo yamasya putro abhyudiyāya rājan (kar.p. 68.47)
Bṛhaspati-rohiṇîm samprapiḍya babhūva candrārka samāna varṇaħ (kar.p. 68.49)

When Karṇa got killed, rivers stopped flowing; Sun set with pollution, the bright sun-coloured planet, son of Yama (Death), appeared across the sky. Jupiter afflicting rohiṇî, became, like Moon and Sun. (p.p.6)

The difficulty in relying on this statement will be clear when we compare this with other versions of the text where the event appears in the 95th Chapter as

Hate karṇe sarito na prasasruh jagāma cāstam savita-divākaraħ
Grahśca tiryak jvalanārka varṇaħ somasyaputro abhyudiyāya tiryak (kar.p. 95.49)
Bṛhaspatiħ samparivārya rohiṇîm babhūva candrārka samo viśāmpate (kar.p. 95.51)

Both the versions graphically describe the evening sky, on the seventeenth day of the war. The meaning of the first line quoted above, of both the versions is almost same. Further, the second version asserts Mercury could be seen, where as the first version refers to the risen planet as Yama's offspring (?), which is not Mercury. Similarly, the second version strongly implies an occultation of star *rohiṇî* by Jupiter, whereas the first version indicates only nearness of Jupiter to *rohiṇî*. Hence, one can at best conclude that some bright planet was seen in the sky after sun set and Jupiter was not far away from star *rohiṇî*. Again in *śalya parvan* in the context of the next day daylight battle itself we read,

Bhṛgusūnu-dharāputrau śaśijena samanvitau
Caramam pāṇḍuputrāṇām purastāt sarva-bhūbhujām (sal.p. 11.17)

Venus and Mars along with Mercury appeared behind the Pāṇḍavas. (p.p.7)

This verse is not available in all the editions of MB. In particular, the Pune edition does not have this statement. In the beginning of *bhîṣma parvan* itself the camping positions have been described, to understand the phrase 'behind the Pandavas'

Prāṅgmukhāħ paścime bhāge nyaviśanta sasainikāħ (bhi.p. 1.5)

Pāṇḍavas camped on the western side (of Kurukṣetra) facing east.

Hence, the planetary positions of p.p.7, if taken as reliable, would be broadly applicable to the western part of the evening sky.

Admittedly, the variant readings of the text bring in an element of uncertainty about the correctness of the stated planetary positions. The traditional rendering of *śvetograhaħ* to mean *ketu,* as by Nỉlakaṇṭha in his commentary adds to the confusion. He goes to the extent of interpreting the text at p.p.3 above and the eclipse mention a line before that to mean,

Kārtikyāħ param hi saṅgrāmārambhaħ, tatra tulāstham arkam rāhurupaiti. Tadeva śveto grahaħ ketuħ citrām atikrāmati svātyādau vartate. Nityam sama-saptakasthau rāhu-ketū idānỉm eka-rāśi-gatau mahā-aniṣṭa sūcakau iti bhāvaħ. (bhỉ.p. 3.11-12)

After kārtika (fullmoon) is the start of the war. There, Rāhu approaches Sun in tulā (Libra). That white planet Ketu crosses citrā (star) and resides in the beginning of svāti. Rāhu and Ketu, who always stay diametrically opposite at the seventh places, being now in the same sign, are indicative of great calamity; is the meaning.

Ganguly in his translation also adopts the same interpretation. This would mean that the ascending and descending nodes of Moon were together during the MB war, which statement cannot be taken seriously. The white planet referred in the text should have been a visible planet not requiring any convoluted interpretations. Not withstanding some such difficulties, there are no reasons to ignore the above citations of eclipses and planetary positions as being fictitious. They could be approximate and even erroneous due to recording errors, but from the context and style of the text on the whole, they have to be accepted as genuine observations. The reigning star or *nakṣatra* citations have been explicitly associated with the position of the moon, as already noted. It follows for the planetary positions also the same observational approach should have been used with the help of the night sky. Even though the textual planetary positions p.p.4; p.p.5; p.p.6 and p.p.7 cannot be taken on their face value, the positions p.p.1, p.p.2, p.p.3 should be reliable since all editions agree on these. Also all editions agree on the occurrence of a solar eclipse in the year of the war, even though the relative timing of this event with respect to the war is not clear. About eclipses at other places there is concordance among all editions of the epic. Hence it is worthwhile to study the internal consistency of eclipses and planetary positions, which automatically means finding one or more dates compatible with all or at least a majority of the textual statements. Specifically, three solar eclipses, one each from s*abhā parvan* (SE1), *bhỉṣma parvan* (SE2) and *mausala parvan* (SE3), have to be found satisfying a time sequence. The first or the second or both could have succeeded or preceded a lunar eclipse in the same month (denoted further as Double Eclipse). While the first two should have been observable at Kurukṣetra, the third one should have been observed at Dvārakā, in the 36th year reckoned from the month of MB war. The interval between the first and the second is not stated in the text. But from other considerations it is known that fourteen years should have elapsed between the gambling episode of s*abhā parvan* and the war commencement in *bhỉṣma parvan.* The text is not clear on how long Pāṇđavas stayed at Upaplavya town, before the start of the war. But it can be inferred that they did not fight in the same year, within a few months, after their thirteen year exile was completed. This we see, in all editions, in the statement of Kṛṣṇa during his speech in the conclave of kings at Upaplavya;

Katham goharanehyuktam naitat śarma tathā hitam
Yācya-mānopi bhỉşmeṇa ***samvatsara-gate*** *adhvani (udy.p. 88.19-20)*

How, during the journey ***about a year ago*** *after the cattle stealing episode, even when Bhỉşma pleaded for peace…...*

In *sabhā parvan*, (chapter 75) before going to the forest both Bhỉma and Arjuna, say that they will come back and fight in the fourteenth year that is, after their exile of thirteen years. But the above statement of Kŗşņa should be taken to indicate that they waited for a year more. Still, this does not resolve when SE1 occurred. Hence we are forced to take a sliding window of 13-15 years as the possible interval between SE1 and SE2. Interestingly, the planetary position mentioned in p.p.1 and p.p.2 come in handy in fixing SE2. These are unambiguous about Saturn being near star *rohiṇỉ* in the war year. The Sanskrit name for Saturn is appropriately *śanaiścara,* meaning one-who-moves-slowly. Thus, the position of Saturn would be the most reliable among the planets. However, two conflicting statements appear later. First, *sūryaputra* (son of Sun) which in later times meant Saturn, is associated with star *Bhaga,* that is same as *Purva-phalguni* (δ-Leonis) in p.p.4. Next, Saturn unambiguously referred as *śanaiścara* is once again located with v*iśākhe* in p.p.5. Now this situation hints at the possibility of these two positions having occurred at some other time and/or errors having crept into the text. Verses corresponding to p.p.5 and p.p.4 might have come into their present positions due to some recording errors. When Yudhişţhira, after the *rājasūya* sacrifice asks for clarification from Vyāsa regarding the three types of portents previously mentioned to him by Nārada, the text indeed sounds incomplete. What were the celestial and atmospheric anomalies? Could the double eclipse be one of them? There is a conversation between Vyāsa and Dhŗtarāşţra in *sabhā parvan*, which is too short by the standards of the epic. Is it possible some of the verses of *bhỉşma parvan* refer to episodes of *sabhā parvan*? Alternatively, is it possible what Vidura mentions and later Dhŗtarāşţra muses, as an eclipse (SE1) at an odd time at the end of *sabhā parvan* could be the one, with Saturn near *viśākhā*? Before this can be discussed further, it is useful to have a list of double eclipses with Saturn near *rohiṇỉ*. For this purpose, modern planetarium softwares come handy.

PVIS, EZC-Planetarium Software

Among several planetarium softwares available, it is found that the planet visibility software PVIS, is user friendly for eclipse search (Fig.1). For finding planetary positions, softwares such as EZC, Hplanet, Skyglobe, can be easily handled. Here the period of search has been restricted to the interval 501 BC–3250 BC. In the discussions available in the book by Gupta and Ramachandran(1976), it is found that all scholars agree that MB should have been before 900 BC. However, since Kŗşņa is accepted in all traditions to be earlier than the historical personality of Gotama Buddha (563-483 BC), here 501 BC is selected as the lower limit. The upper limit is chosen to cover the traditional date of start of Kaliyuga, namely, 3102 BC. The location for the eclipse search has been taken as Kurukşetra at $76^0$49’E and $29^0$59’N. Initially each year in the above time interval is searched for occurrence of solar eclipses. This is followed by a search for lunar eclipses only in years with solar eclipses. It is found that in the period under consideration 267 such double eclipses were possible. Among the 267 double eclipses, our interest is initially restricted to those during which Saturn was near *rohiṇī.* These results are presented in Table 1. Since Saturn has a long period of nearly 30 years to complete a cycle, it may be safely concluded that in the war year during the eclipse, Saturn should have been near *rohiṇī*. The planetary positions are as seen from the sky chart of EZC software. The nearness to the star is liberally interpreted to mean a wide interval of two stars on either side of *rohiṇī.* This way, solutions even if they are remotely possible, are not left out at the first level of sorting. No effort is made to resolve the positions of the planets more accurately since the textual statements, which were naked eye observations, have to be taken as true but approximate.

Search for SE3 and SE1

All solar eclipses preceded or succeeded by a lunar eclipse in the same month and with Saturn near *rohiṇī* are listed in Table 1. Since all these years are possible candidates for the war year, any compatible SE3 should have occurred 35 years later reckoned from the *kārtika* month of these years. In Table 1, solar eclipses visible at Dvārakā (22° N, 69° E) 34-36 years after SE2 are also listed. It is observed that among the 35 solutions for SE2 only sixteen are compatible with SE3. Thus, further search for SE1 would naturally get limited to these sixteen pairs of (SE2, SE3) only. For each of these SE2 years, all possible antecedent solar eclipses at intervals of 13,14 and15 years are found. The results of such a search are presented in Table 2. For sake of completeness, lunar eclipses if any in the resulting years are also listed. The positions of Saturn and Jupiter on the night of SE1 date are listed for later discussions. It is seen that out of the sixteen possibilities of (SE2, SE3) only eleven cases have had a solar eclipse SE1 occurring at the required interval. Thus, a detailed search and analysis of 2750 years of data produces eleven possible sequences of three eclipses, as being compatible with the statements appearing in the text of MB. These triplets (SE1, SE2, SE3) in chronological order are (520,505,469/70); (724,711,676); (811,798,763); (843,830,795/96); (1493/91,1478,1443/44); (2638,2624,2588/89); (2758/57/56,2743,2708); (2759/58/57,2744,2709); (3021,3008,2973); (3168,3154,3119); (3200/3198,3185,3151). It is recalled that all these sequences are compatible with the position of Saturn being near star *rohiṇī* during the war. The only other reliable text available for further analysis is that before the war, on a *kārtika-kṛṣṇa-aṣṭami* night, Mars was between *jyeṣṭha* and *anūrādhā* (p.p.1). With this in view for all the eight SE2 years, the planetary positions on the corresponding *kārtika-kṛṣṇa-aṣṭami* night as per EZC software are listed in Table 3. For finding the Julian date corresponding to an Indian date up to 3102 BC, the *Pancanga* software of Yano (http://kyoto-u.ac.jp/pub/doc/sanskrit/pancanga/) has been used. Now, it is observed from this table that there is only one SE2 year, namely 1478 BC, satisfying the stated position of Mars. The sky chart for 20.9.1478 BC is shown in Fig.2a and Fig.2b for two different times. Mars, on this date was not in retrograde motion; but Saturn was. Mars had completed its retrograde motion four months earlier, in the same year. To this extent, the observation of Mars may be inaccurate or taking Mars to be *vakra* could be a poetic fancy. It is clear from the figures that the un-named planet said to be afflicting star *citrā* in p.p.1 should have been Mercury. This also matches with the further reliable statement of Vyāsa (p.p.3) on the following *kārtika-pūrṇimā* night (12.10.1478 BC) that a white planet had crossed star *citrā.* These positions can be seen in the early morning and evening sky charts for this date shown in Fig.3a and Fig.3b.

Hypothesis

The above results point out that the text is internally consistent with respect to eclipses and the first planetary position of Saturn and Mars. However, the problem of the other statements from p.p.4 onwards remains to be sorted out. For this purpose, we proceed as follows. In Table 2, for the solar eclipse date in 1493 BC, the position of Saturn is seen to be near *viśākha.* It is only natural that if in the year of the war Saturn was near *rohiṇí*, some fifteen years earlier Saturn should have been near *viśākha.* This agrees with the text at p.p.5, except that its relative position in the epic appears misplaced. Thus, it is hypothesized that whereas the text stating the planetary positions p.p.1; p.p.2 and p.p.3, refer to the war year, the later textual statements refer to events of *sabha parvan.* This hypothesis stands largely verified since the period 1493-1478 BC is compatible with the planetary positions mentioned in p.p.4 and p.p.5 as seen from Table 4, where the planetary positions are listed for some years arising as possible solutions during this period.

Analysis

The results of Table 3 and Table 4 are self-explanatory. Eleven sequences of triplets have been identified as being compatible with the eclipses of the MB text. The least controversial p.p.1, mentions Mars as being between *jyeṣṭha* and *anūrādhā*. This observation fits in with only one of the eleven solutions namely, 20.9.1478BC. The sky chart for this date is also shown in Fig.2a, and Fig.2b. This confirms that the celestial observations of MB could have been possible only in the period 1493BC-1443BC. It may be emphasized here that the two lengthy, but ambiguous, positions p.p.4 and p.p.5 have not been used to identify the above epoch as the historic period of the observations. In the identified year 1478 BC of the war not only a compatible double eclipse (SE2) was possible (Fig.1) but also the planetary positions p.p.1 (Fig.2a, 2b) and p.p2; p.p3 were satisfied (Fig.3a, 3b). The controversial positions p.p.4 and p.p.5 also get reasonably well confirmed, if they are taken to belong to a previous year of great importance in the epic. Table 4 again indicates 19.3.1493 BC (SE1) as the most likely date of observation for p.p.5. Both Saturn and Jupiter were near *viśākha* as mentioned (Fig. 4b). There was no planet in the *kṛttikā* cluster. This may be in order, since the text only mentions a comet like planet in *kṛrttikā*. From the same figure, it is seen that Mars was near star *maghā* as mentioned in p.p.4. It can be verified that Mars was in retrograde a month earlier and the loop had not yet been completed by the above date (Fig. 4c). The sky chart for the same date at 5.30 hours (local time) just before sunrise is shown in Fig 4a, where the positions of Venus and Jupiter can be seen. Now, it is easy to conjecture that the positions of Jupiter given in p.p.4 and p.p.5 are perhaps same. In the former, it is mentioned as being near *śravaṇa*, while in the latter it is said to be near *viśākha.* The position of Venus in *pūrvābhādrā or pūrva-proṣṭhapada* was also valid for this date as given in p.p.4. Further, it can be seen from Fig 4c that the movement of Venus mentioned, as having risen previously in *proṣṭhapada* and after circling northwards to be seen with another planet was true. This figure shows the motion of Venus for a period of three months prior to 19.3.1493 BC. The anonymous planet with which Venus was seen should have been Mercury before sunrise. If the star that was traversed by Venus is taken as *uttarā,* then also the text fits in with the actual positions since, Table 4 supports this for the next solar eclipse date. The sky chart for the night of 12.10.1478 BC at 17.55 hours local time is shown in Fig.3b. Venus was seen for some time in the western sky with Mars, after sunset. This chart indicates that the fiery dark planet (*śyāmo grahaħ*) in *jyeşţha* was perhaps Mars on the eve of the war. From Fig.3a, it is seen that the rough planet between *citrā* and *svātỉ* could have been Uranus. Thus, p.p.4 may contain some statements corresponding to the war year and some corresponding to a previous episode. Back calculation of eclipses and planetary positions uphold the hypothesis that some of the verses in *bhỉşma parvan* of the text should belong, in all likely hood, to the conversation between Vyāsa and Dhŗtarāşţra towards the end of *sabhā parvan* or beginning of *araņya parvan.* The remaining planetary positions for the 13th and the 18th day of the war are not reliable as indicated by wide differences in the various editions.

Discussion

There are many clues in the text of MB for fixing dates within a year. For example, one can easily guess that the war should have started immediately after a *kārtika-pūrņimā.* Similarly we find that Bhỉşma died on or very near the day of winter solstice. But such informations are not sufficient to fix the epoch or macro-date of the epic. The longest historic time interval the epic mentions is the thirty-six year time period between the war and the end of the clan of Vŗşņis including Kŗşņa. Internal evidence in the text indicates the war was used as an origin to mention another time period namely the length of stay of Dhŗtarāşţra with Pāņđavas as fifteen years. Thus to estimate the year of the war with reference to a longer or present day time frame, one needs reliable observations of dateable events. Fortunately, the epic contains several observations of eclipses and planet positions. Some of these may be approximate and even difficult to interpret today. The present effort has been to interpret the celestial observations of the text with the help of modern computer softwares. The primary question asked is whether or not the various statements of the epic are internally compatible. From the extensive search of solar and lunar eclipses and planetary positions carried out, it is found that the textual statements are consistent among themselves provided, they were observed during the period 1493-1443BC. In fact one can quite accurately estimate that the war should have taken place in the year 1478BC. This result may have an error band of one year, since the intervals between the three constraining eclipses are uncertain to the extent of one year. Also, while we have followed the solar year for our calculations, it is not known which system has been followed by the text. It is important to point out another aspect of the present approach. The work reported and the results obtained are based on the premise that the double eclipse mentioned in the text occurred in the war year. A close look at the text in p.p.5 of *bhỉşma parvan* (3.29) gives a feeling that this could as well be associated with the position of Saturn and Jupiter being near *viśākha*, which has been identified previously with an earlier eclipse (SE1). This raises the question whether other results would be possible if one starts with SE1 as a double eclipse with Saturn and Jupiter being near *viśākha* in that year. The reverse search to identify SE2 and SE3 starting from all possible SE1 years has also been carried out. In Table 5, all possible double eclipses observable at Kurukşetra in the search period, when Saturn and Jupiter were near *viśākha* are listed. From this table another list of possible solar eclipses 13-15 years later with Saturn being near *rohiņỉ* are prepared and shown in Table 6. In this table, the possibilities of an eclipse (SE3) after 35 years from SE2 are also indicated. It is seen that there are three triplets (1198,1185/83,1150), (1493,1479/78,1444/43), (1932,1919,1884) which satisfy the relative time sequence of the eclipses and the important Saturn positions. It is interesting to see that the second among this new sequence is nearly same as the one previously discovered as the MB eclipse triplet. For the four possible SE2 years of this sequence, the position of Mars as per p.p.1 on the *kārtika-kṛṣṇa-aṣṭami* night is presented in the last four rows of Table 3. Even with this alternate interpretation and extensive reverse search, year 1478 BC remains as the unique and most likely year of the war.

It has not been possible to interpret *sūrya-putra* said to be near *pūrva-phalguni.* This may not be a serious limitation because reference to Saturn as *śanaiścara* is more reliable than the mythological name *sūrya-putra*. The last verse of (p.p.4) referring to Mars (?) also has not been fully interpreted here. In the present analysis, the positioning of the planets with the stars has been done by inspection of the star chart as shown by the software EZC. Certain level of subjectivity is unavoidable in such an exercise. Fixing the position of planets more accurately is possible, but is not warranted in view of the approximate nature of the textual observations. There are again limitations with any eclipse search exercise. For this we have relied on the software PVIS. If another software is used one may get slightly different results. However, it is felt that any objective exercise will lead to a period not far different from what has been obtained here. The result of Sharma (1986), who obtained 1493 BC as the possible war year, amply demonstrates this point.

Summary and Conclusion

The internal consistency of the eclipses and planetary positions mentioned in Mahābhārata has been studied in this paper from a novel perspective. After a brief review of interesting astronomical information given in the text, including a theory of eclipses, the data base available for back calculations of eclipses and planetary positions is listed with variant readings. A simple working translation of the archaic statements, part of which is in conflict with the traditional interpretation, is also provided. There is a clear reference in the text to a double eclipse, that is a lunar and a solar eclipse in either order, with in the period of one month. However, it is not clear from the position of the text whether this was with Saturn near *rohiṇī* or the Saturn-Jupiter combine near *viśākha.* To resolve this issue all solar eclipses and double eclipses during 501 BC-3250 BC have been determined for Kurukşetra and classified into two groups. The constraint that in the 36th year after the war, a solar eclipse was observed at Dvārakā is also used. This exercise leads to several possible dates for the MB war. At this stage invoking the non-controversial statement in *udyoga parvan* that Mars was between stars *jyeṣṭhā* and *anūrādhā* it is found that 1478(±1) BC is the unique solution to the year of the war of the epic. It is demonstrated, using only the most reliable verses of the text that, some of the statements appearing in *bhīṣma parvan* should refer to or belong to *sabhā parvan* and hence almost all the celestial observations of MB are internally compatible. Wrong sequencing of texts in ancient manuscripts, based on which the present day printed versions are made available, is not unusual. In a text as large as MB it is no wonder the chronological ordering of the events and observations might have got mixed up due to transmission errors. Still it is remarkable, everything falls into place as in a puzzle and an almost unique epoch emerges for the celestial observations.

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Table 1. Double eclipses observable at Kuruksetra during 501-3250 BC

Rohini Series

No.	Year BC	Lunar eclipse	Solar eclipse	Saturn	S.E at Dwaraka after 35 years
1	505	31 Jan	16 Feb	Bharani	1.9.469; 20.3.470
2	624	23 Jun	8 July	Bharani	N.P
3	679	1 June	17 June	Mrgasira	N.P
4	711	27 Feb	14 March	Bha-Krttika	15.4.676
5	768	21 Sept	7 Sept	Rohi-Mrga	N.P
6	798	23 Nov	7 Nov	Rohini	15.6.763
7	830	14 Jan 829	30 Dec	Asvini	6.9.795; 24.3.796
8	974	19 Oct	4 Oct	Rohini	N.P
9	1122	5 Oct	21 Sept	Rohini	N.P
10	1154	3 July	18 June	Asvini	N.P
11	1181	1 June	16 June	Rohini	N.P
12	1183	27 Jan	12 Jan	Asvini	N.P
13	1328	1 Nov	17 Oct	Roh-Mrga	N.P
14	1478	16 May	1 June	Bhar-Krtt	7.1.1443, 18.1.1444
15	1710	26 Oct	10 Nov	Ardra	N.P
16	1711	11 June	27 May	Rohini	N.P
17	1713	8 Jan	22 Jan	Asvini	8.8.1677; 23.2.1678
18	1832	29 May	13 June	Asvi-Bhar	N.P
19	1861	24Dec’62	9 Jan	Rev-Asvi	10.2.1826
20	1917	7 July	23 June	Mrgasira	N.P
21	2213	5 Nov	20 Nov	Krttika	N.P
22	2215	6 Jan	22 Jan	Rev-Asvi	23.2.2180
23	2567	19 Nov	4 Dec	Krttika	N.P
24	2594	18 Nov	3 Nov	Mrgasira	N.P
25	2682	8 Feb	24 Feb	Mrgasira	28.3.2647
26	2624	30Dec	13 Jan	Krttika	4.2.2588; 11.8.2589
27	2743	15 Nov	31 Oct	Krttika	8.7.2708
28	2744	1 June	16 June	Krttika	24.1.2709
29	2774	1 August	18 July	Bhar-Krtt	N.P

30	2889	10 Sept	26 Sept	Mrga-Ardra	N.P
31	2950	28 June	13 July	Krttika	19.2.2915; 15.8.2915; 4.8.2914.
32	3006	22 Jan	7 Jan	Rohiņỉ	N.P
33	3008	8 August	23 August	Rohiņỉ	24.9.2973
34	3154	8 Jan	25 Dec'55	Rohiņỉ	26.1.3119
35	3185	20 Feb	6 March	Kŗttikā	12.10.3151

Table 2. Compatible eclipse years from Table 1.
(N.P = Not Possible)

No.	Year BC	Lunar eclipse	Solar eclipse	Saturn	Jupiter
1	505	31.1	16.2	Bharani	Purvabhadra
	518	--	N.P	--	--
	519	--	N.P	--	--
	520	8.11	23.11	Anuradha	Uttarasadha
2	711	27.2	14.3	Bhar-Krttika	Anuradha
	724	N.P	6.5	Mula	Svati
	725	--	N.P	--	--
	726	--	N.P	--	--
3	798	23.11	7.11	Rohini	Magha
	811	N.P	30.12	Purvasadha	Punarvasu
	812	--	N.P	--	--
	813	--	N.P	--	--
4	830	14.1.829	30.12	Asvini	Jyestha
	843	N.P	2.5,26.9	Anuradha	Citra
	844	--	N.P	--	--
	845	--	N.P	--	--
5	1478	16.5;10.11	1.6	Rohini	Revati
	1491	11.2	23.7	Anu-Visakha	Dhanistha
	1492	--	N.P	--	--
	1493	4.3	19.3	Visakha	Mula
6	1713	8.1	22.1	Rohini	Krttika
	1726	--	N.P	--	--
	1727	--	N.P	--	--
	1728	--	N.P	--	--
7	1861	24.12.'62	9.1	Revati-Asvini	Jyestha
	1874	----	N.P	----	-----
	1875	----	N.P	----	-----
	1876	---	N.P	----	-----

8	2215	6.1	22.1	Asvini	Sravana
	2228	--	N.P	--	--
	2229	--	N.P	--	--
	2230	--	N.P	--	--
9	2624	30.12.’25	13.1	Krttika	Pusya
	2637	----	N.P	----	-----
	2638	N.P	19.3	Mula	Rohi-Mrga
	2639	----	N.P	----	----
10	2682	8.2	24.2	Rohini	Citra
	2695	--	N.P	--	--
	2696	--	N.P	--	--
	2697	--	N.P	--	--
11	2743	15.11	31.10	Rohini	Magha
	2756	N.P	28.7	Jyestha	Punarvasu
	2757	22.8	8.8	Jyestha	Ardra
	2758	10.3	25.3	Anuradha	Asvini
12	2744	1.6	16.6	Rohini	Pusya
	2757	22.8	8.8	Jyestha	Ardra
	2758	10.3	25.3	Anuradha	Asvini
	2759	--	5.4	Visakha	U.bhadra
13	2950	28.6	13.7	Rohini	Dhanistha
	2963	--	N.P	--	--
	2964	--	N.P	--	--
	2965	--	N.P	--	--
14	3008	8.8	23.8	Rohini	Revati
	3021	29.10	15.10	Mūla	Dhanişṭhā
	3022	--	--	--	--
	3023	--	--	--	--
15	3154	8.1	25.12’55	Rohini	
	3167	--	N.P	--	--
	3168	--	28.3	Mūla	Hasta
	3169	--	--	--	--
16	3185	20.2	6.3	Kṛttika	
	3198	13.5	28.9	Mūla	P.bhādra
	3199	--	--	--	--
	3200	--	18.6	Anūrādhā	S’ravaṇa

Table3. Planetary positions as per EZC on kārtika-kŗşņa-aşţami of possible SE2 years

Date-BC	Saturn	Jupiter	Venus	Mars
1.10.505	Krttika	Revati	Svati	Bharani
29.9.711	Krttika	Anuradha	Visakha	Citra
1.10.798	Rohini	Magha	Hasta	Magha
26.9.830	Krttika	Anuradha	Uttara	Magha
20.9.1478	Bhar-Krtt	Purvabhadra	Jyestha	Jyestha-Anuradha
31.8.2624	Mrgasira	Purva	Jyestha	Uttara
27.8.2743	Krttika	Magha	Citra-Svati	Ardra
6.9.2744	Krttika	Pusya	Jyestha	Citra-Svati
17.8.3008	Rohiņỉ	Revatỉ	Viśākha	Puşya
8.9.3154	Mŗgaśirā	Jyestha	Citrā	Viśā-Svāti*
25.9.3185	Rohiņỉ	Kŗttikā	Svāti	Mŗgaśirā
28.9.1183	Bhar-Krttika	Srav-Dhani	Svati	Citra
20.9.1185	Revati	Jyestha	Uttara	Hasta
30.9.1479	Asvini	Dhanistha	Citra-Svati	Pusya
6.9.1919	Bhar-Krttika	Sravana	Mula	Punarvasu-Pusya

(*Not visible due to nearness to Sun)

Table 4.Planetary Positions for sequence 1493-1478 B.C.

Date -BC	Saturn	Jupiter	Venus	Mars	Remarks
19.3.1493	Visakha	Mula	P.bhadra	Magha	Solar Eclipse
23.7.1491	Anu-Vis	Dhanista	Uttara	Visakha	Solar Eclipse
11.6.1479	Asvini	Shatabhishak	Punarvasu	Krttika-Rohini	Solar Eclipse
1.6.1478	Bharani-Krttika	Revati	Punarvasu	U.phalguni	Solar Eclipse
20.9.1478	Bhar-Krtt	P.bhadra	Jyestha	Jyestha-Anuradha	Kartika Krsnastami
12.10.1478	Bhar-Krtt	U.bhadra	P.asadha	Jyestha-Mula	Kartika Purnima

Table 5. Double eclipses observable at Kurukşetra during 501-3250 BC
Viśākha Series

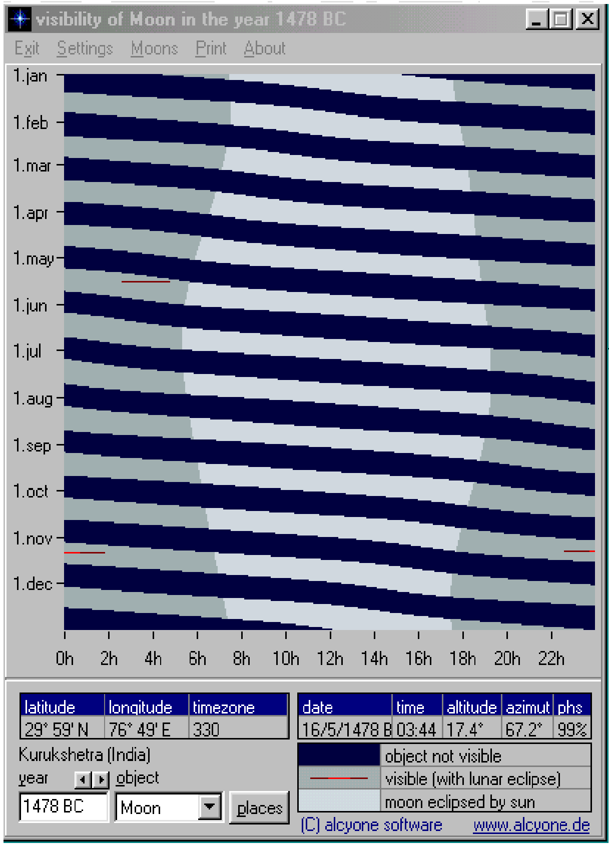
No.	Year BC	Lunar eclipse	Solar eclipse	Saturn	Jupiter
1	664	13 Aug	28 Aug	Mula	Visakha
2	758	1 Sept	17 Sept	Svati	Jyestha
3	782	30 June	15 June	Mula	Anuradha
4	876	18 July	4 July	Citra	Mula
5	1198	4 Nov	21 Oct	Anuradha	Anuradha
6	1375	18 May	3 May	Visakha	Anuradha
7	1436	28 August	13 August	Citra-Svati	Citra-Svati
8	1493	4 March	19 March	Visakha	Mula
9	1849	1 Nov	17 Nov	Sva-Vis	Jye-Mula
10	1932	26 April	11 April	Jyestha	Jyestha
11	2051	16 Sept	2 Sept	Anuradha	Jyestha
12	2053	13 April	29 April	Visakha	Hasta-Citra
13	2171	28 Feb	14 Feb	Visakha	Sva-Vis
14	2289	5 Dec	20 Dec	Visakha	Jyestha
15	2406	11 Oct	26 Sept	Visakha	Mula
16	2407	27 April	13 May	Svati	Anuradha
17	2433	9 Sept	24 Sept	Jyestha	Citr-Svati
18	2492	5 June	22 May	Jyestha	Hasta
19	2527	29 Sept	14 Oct	Svati	Visakha
20	2703	24 Sept	10 Sept	Citr-Svati	Jyestha
21	2704	11 April	26 April	Hasta	Visakha
22	2762	22 May	6 June	Svati	Mula

Table 6. Compatible eclipse years from Table 5.
(N.P = Not Possible)

No.	Year BC	Lunar eclipse	Solar eclipse	Saturn	Jupiter	S.E3 at Dwaraka 35 years after war
1	664	13.8	28.8	Mula	Visakha	--
	651		7.6	Rohini	Jyestha	N.P
	650	--	N.P	--	--	--
	649	--	N.P	--	--	--
2	782	30.6	15.6	Mula	Anuradha	--
	769	--	N.P	--	--	--
	768	21.9	7.9	Rohi-Mrga	U'asadha	N.P
	767	--	N.P	--	--	--
3	1198	4.11	21.10	Anuradha	Anuradha	--
	1185	18.2	28.8	Revati	Jyestha	7.4.1150
	1184	--	N.P	--	--	--
	1183	27.1	12.1	Rohini	Sravana	N.P
4	1493	4.3	19.3	Visakha	Mula	--
	1480	--	N.P	--	--	--
	1479	N.P	11.6	Asvini	Sravana	18.1.1444
	1478	16.5;10.11	1.6	Krttika	Revati	7.1.1443
5	1729	31.5	16.5	Sva-Vis	Sravana	--
	1716	--	N.P	--	--	--
	1715	--	N.P	--	--	--
	1714	N.P	29.7	Rohini	Krttika	N.P
6	1932	26.4	11.4	Jyestha	Jyestha	--
	1919	29.7	18.2	Bharani	Sravana	15.9.1884
	1918	--	N.P	--	--	--
	1917	7.7	23.6	Rohini	Sravana	N.P
7	2289	5.12	20.12	Visakha	Jyestha	--
	2276	--	N.P	--	--	--
	2275	--	N.P	--	--	--
	2274	27.2	15.3	Bharani	Dhanistha	N.P
8	2433	9.9	24.9	Jyestha	Cit-Svati	--
	2420	N.P	4.7	Krttika	Cit-Svati	N.P
	2419	2.12	23.6	Rohini	Anuradha	N.P
	2418	--	N.P	--	--	--
9	2492	5.6	22.5	Jyestha	Hasta	--
	2479	--	N.P	--	--	--
	2478	4.3	14.8	Rohini	Jyestha	N.P
	2477	--	N.P	--	--	--

Table 7. Naksatras of Mahābhārata and their identifying stars

No.	Naksatras	Identifying Stars	Star Names	Diety Names
1	Krttika	η Tauri	Alcyone	Agni
2	Rohini	α- ε Tauri	Aldebaran	Brahma
3	Mrgasira	λ, ϕ Orionis	Meissa	Candra
4	Ardra	α Orionis	Betelgeuse	Rudra
5	Punarvasu	β, α Geminorum	Pollux	Aditi
6	Pusya	θ, δ, γ Cancri	Asellus	Brhaspati
7	Aslesa	ε, δ, σ, η, ρ Hydrae	Minhar	Sarpa
8	Magha	α- ε Leonis	Regulus	Pitr
9	Purva-Phalguni	δ Leonis	Zozma	Bhaga
10	Uttara-Phalguni	θ Leonis	Chort	Aryama
11	Uttara	β Leonis	Denebola	
12	Hasta	δ, γ, ε, α, β Corvi	Algorab	Savitri
13	Citra	α Virginis	Spica	Tvastr
14	Svati	α Bootis	Arcturus	Vayu
15	Visakha	α Librae	Zubenelgelubi	Indra-agni
16	Anuradha	δ, β, ∏ Scorpii	Dschubba	Mitra
17	Jyestha	α, σ, τ Scorpii	Antares	Indra
18	Mula	λ- ε Scorpii	Shaula	Nirrti
19	Purvasadha	δ, ε Sagittarii	Kaus Australis	Apaha
20	Uttarasadha	σ, ζ Sagittarii	Nunki	Visva
21	Abhijit	α, ε, ζ Lyrae	Vega	Daksa
22	Sravana	α, β, γ Aquilae	Altair	Visnu
23	Dhanistha	β, α, γ, σ Delphini	Formelhaut	Vasu
24	Satabhisak	λ Aquarii, etc.	Situla	Varuna
25	Purva-Bhadrapada	α, β Pegasi	Markab	Ajaikapat
26	Uttara-Bhadrapada	γ Pegasi, α Andromedae	Alpheratz	Ahirbudhnya
27	Revati	ζ Piscium, etc.	Rischa	Pusan
28	Asvini	α-γ Arietis	Hamal	Asvinau
29	Bharani	35-41 Arietis	41 Arietis	Yama



latitude	longitude	timezone
29° 59' N	76° 49' E	330

date	time	altitude	azimut	phs
16/5/1478 B	03:44	17.4°	67.2°	99%

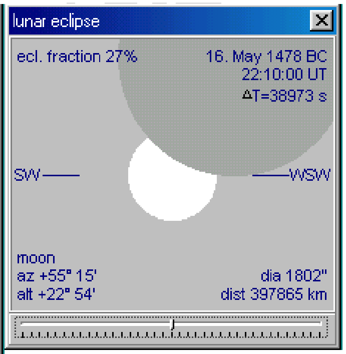
Kurukshetra (India)

year 1478 BC

object Moon

■	object not visible
—	visible (with lunar eclipse)
▨	moon eclipsed by sun

(C) alcyone software www.alcyone.de

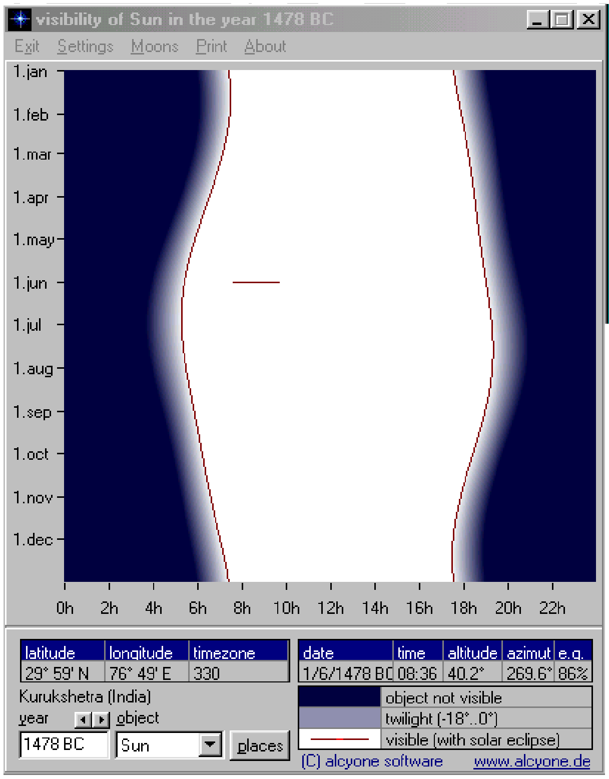


ecl. fraction 27%

16. May 1478 BC
22:10:00 UT
ΔT=38973 s

moon
az +55° 15'
alt +22° 54'

dia 1802"
dist 397865 km



latitude	longitude	timezone
29° 59' N	76° 49' E	330

date	time	altitude	azimut	e.g.
1/6/1478 BC	08:36	40.2°	269.6°	86%

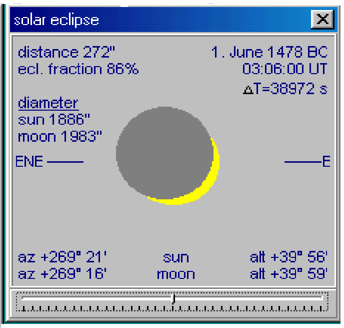
Kurukshetra (India)

year 1478 BC

object Sun

■	object not visible
▨	twilight (-18°..0°)
—	visible (with solar eclipse)

(C) alcyone software www.alcyone.de



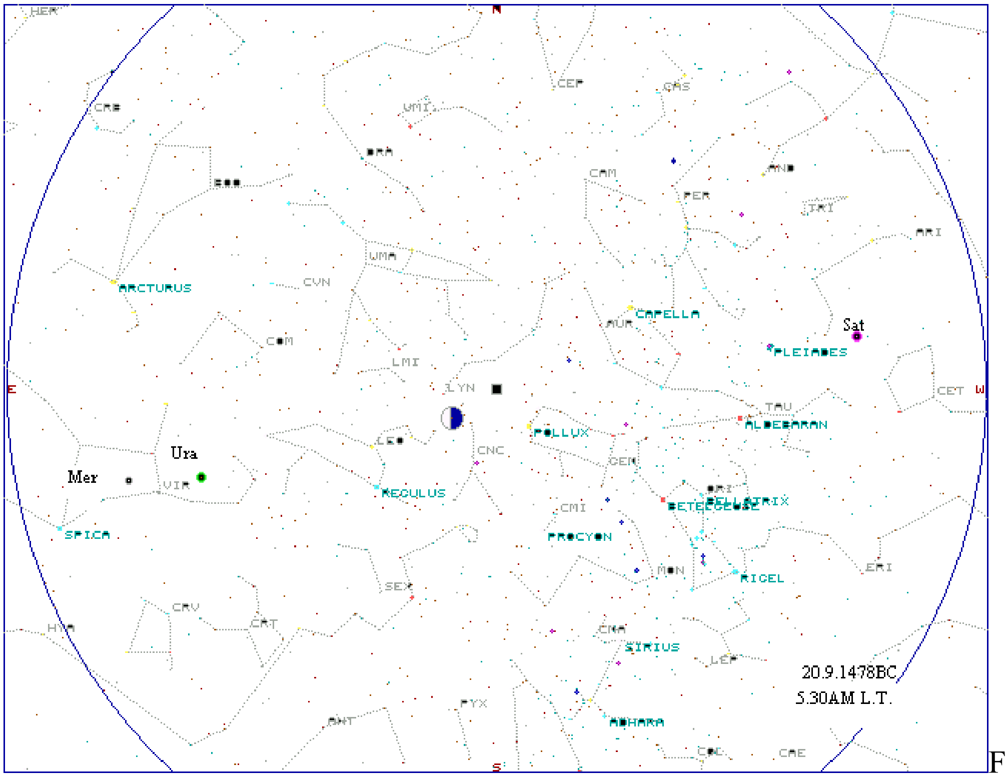
distance 272"
ecl. fraction 86%

1. June 1478 BC
03:06:00 UT
ΔT=38972 s

diameter
sun 1886"
moon 1983"

az		alt
az +269° 21'	sun	alt +39° 56'
az +269° 16'	moon	alt +39° 59'

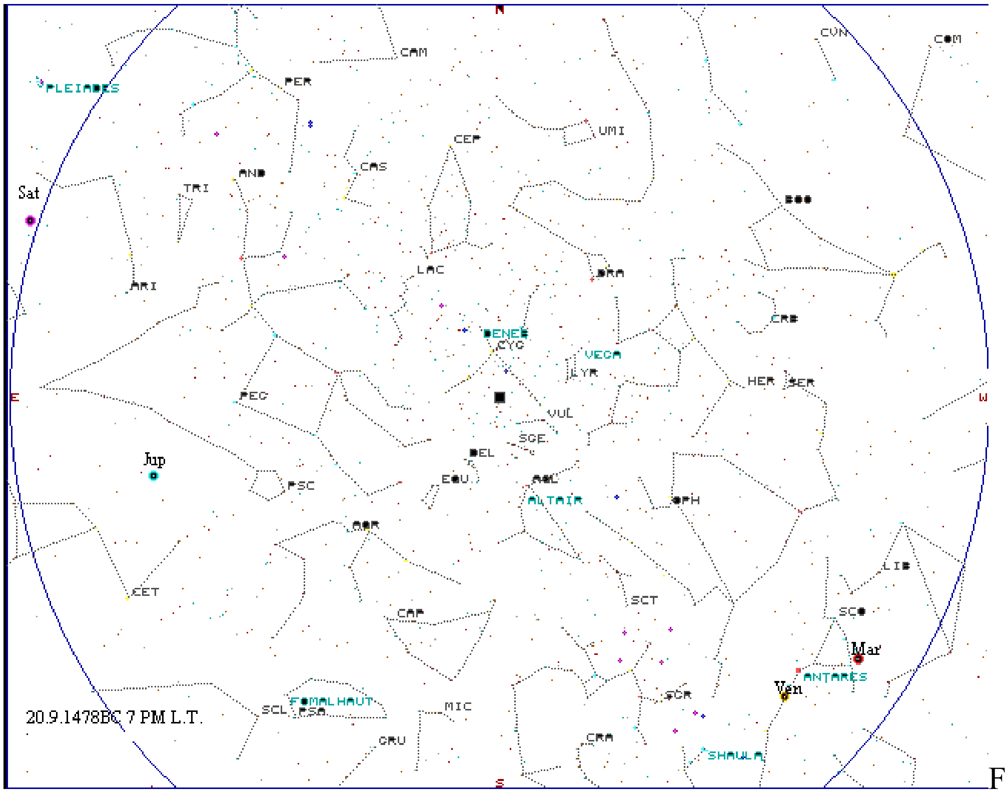
Fig.1. Double Eclipse in 1478BC



20.9.1478BC
5.30AM L.T.

Fig 2a.

Sky Chart for 20.9.1478BC 5.30 AM (LT)



20.9.1478BC 7 PM L.T.

Fig 2b.

Sky Chart for 20.9.1478BC 19 hrs.(LT)

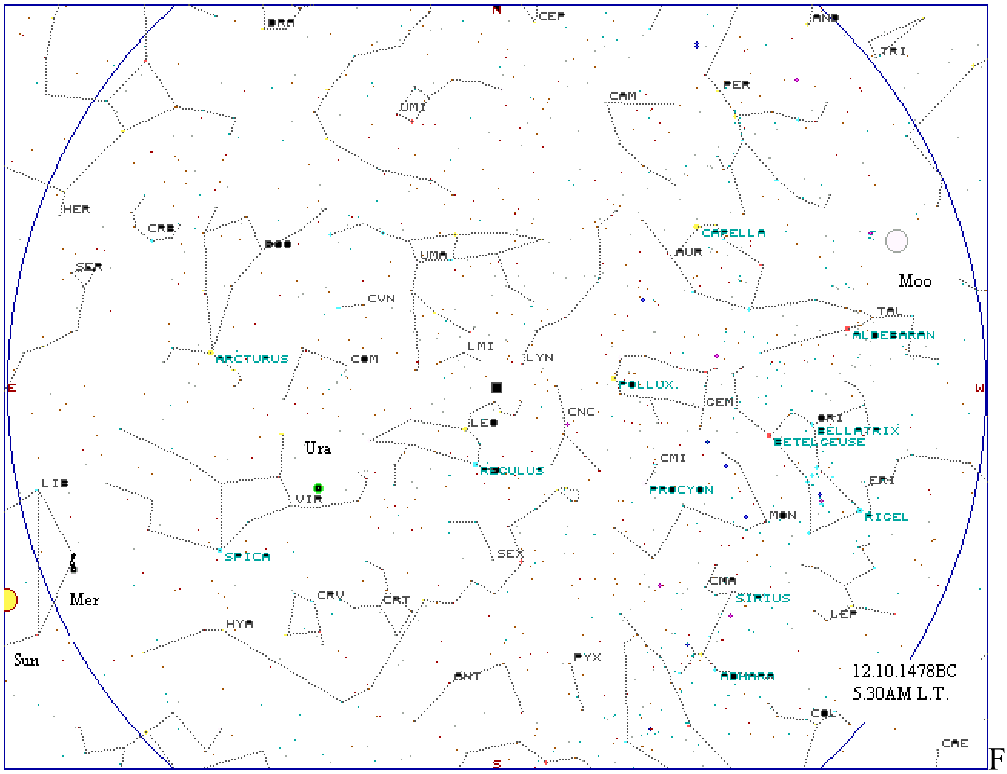


Fig3a.

Sky Chart for 12.10.1478BC 5.30 AM (LT)

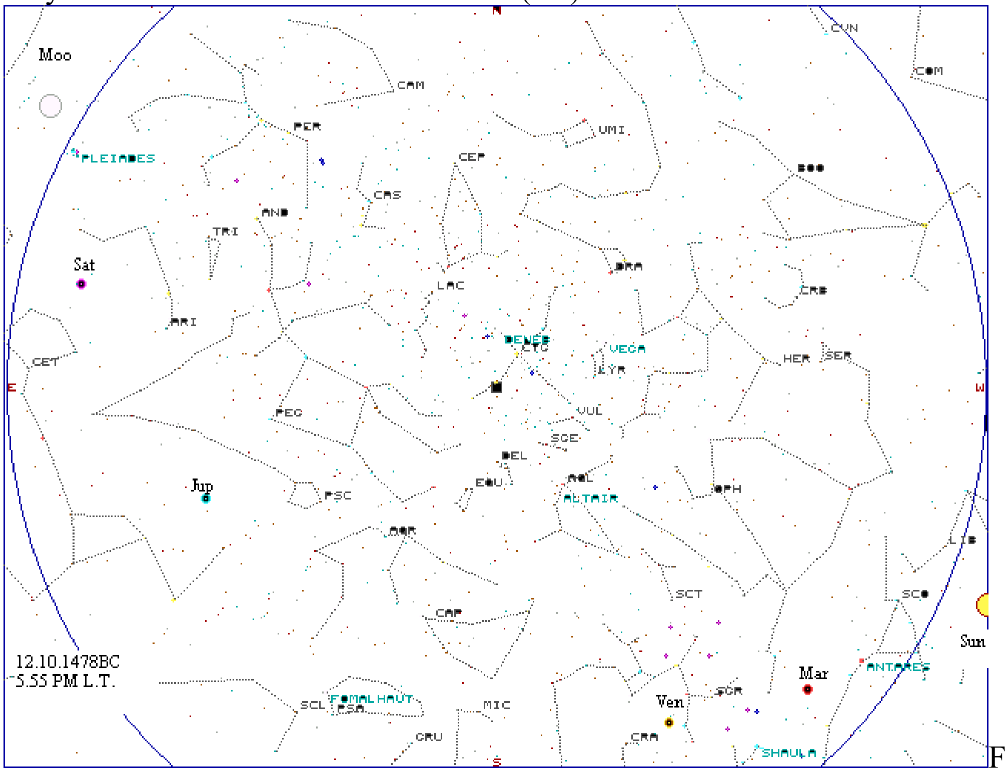


Fig3b.

Sky Chart for 12.10.1478BC 5.55 PM (LT)

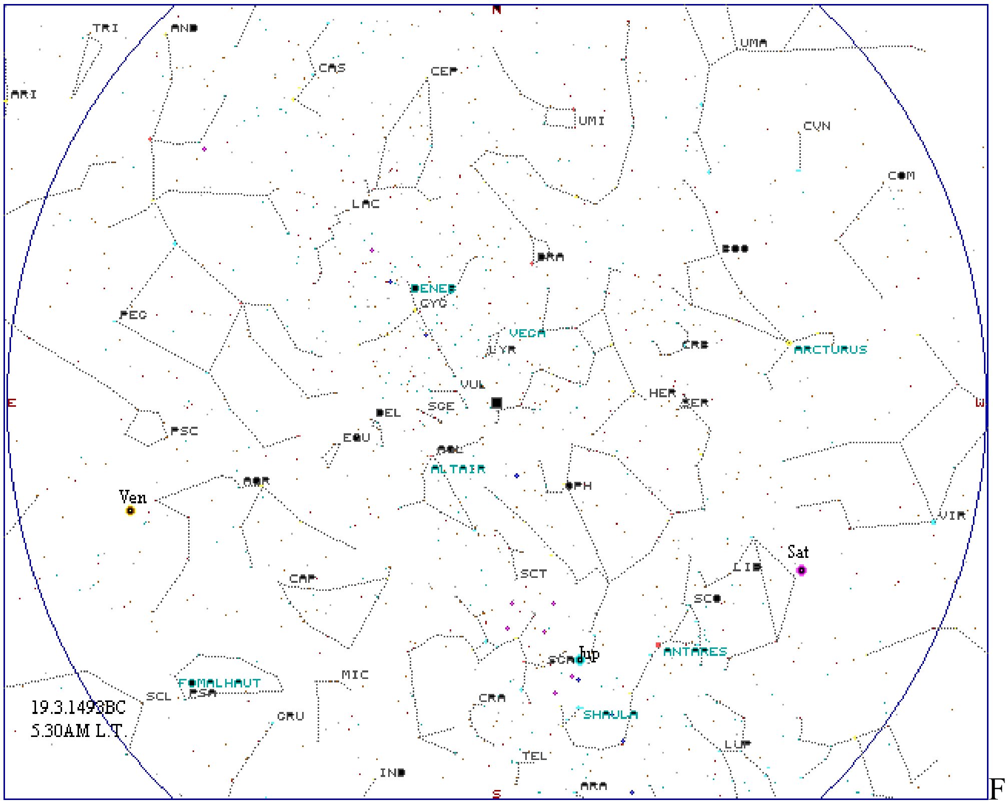


Fig4a.

Sky Chart for 19.3.1493BC 5.30 AM (LT)

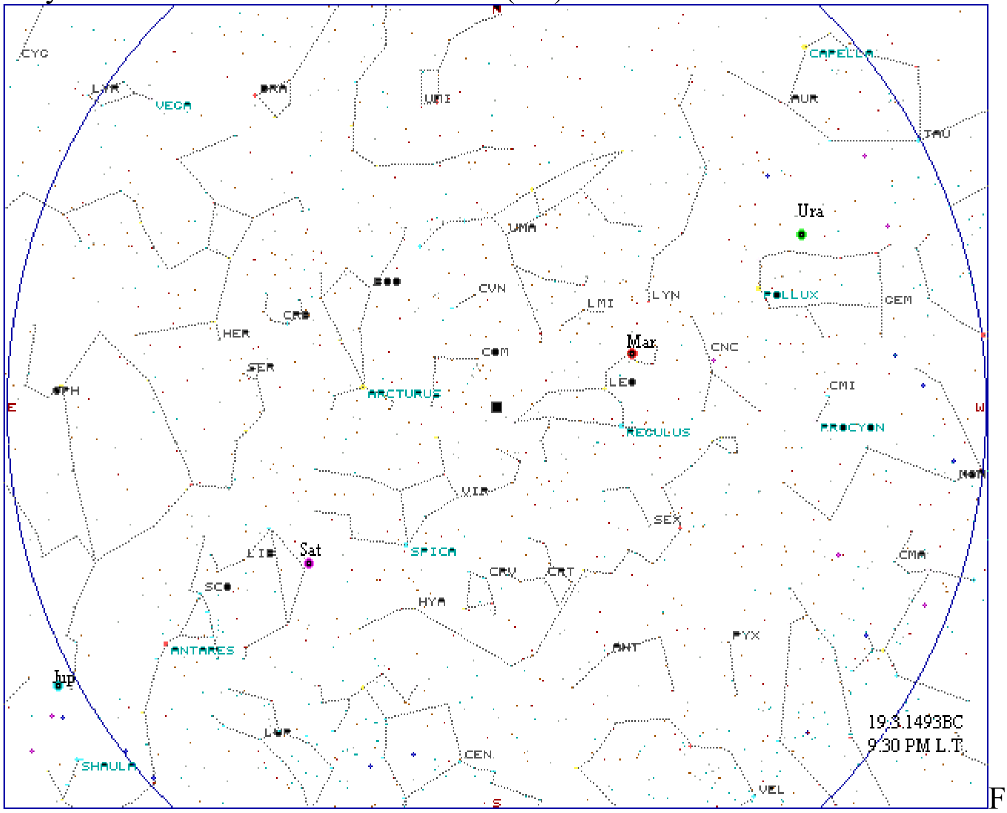


Fig4b

Sky Chart for 19.3.1493 BC 9.30 PM (LT)

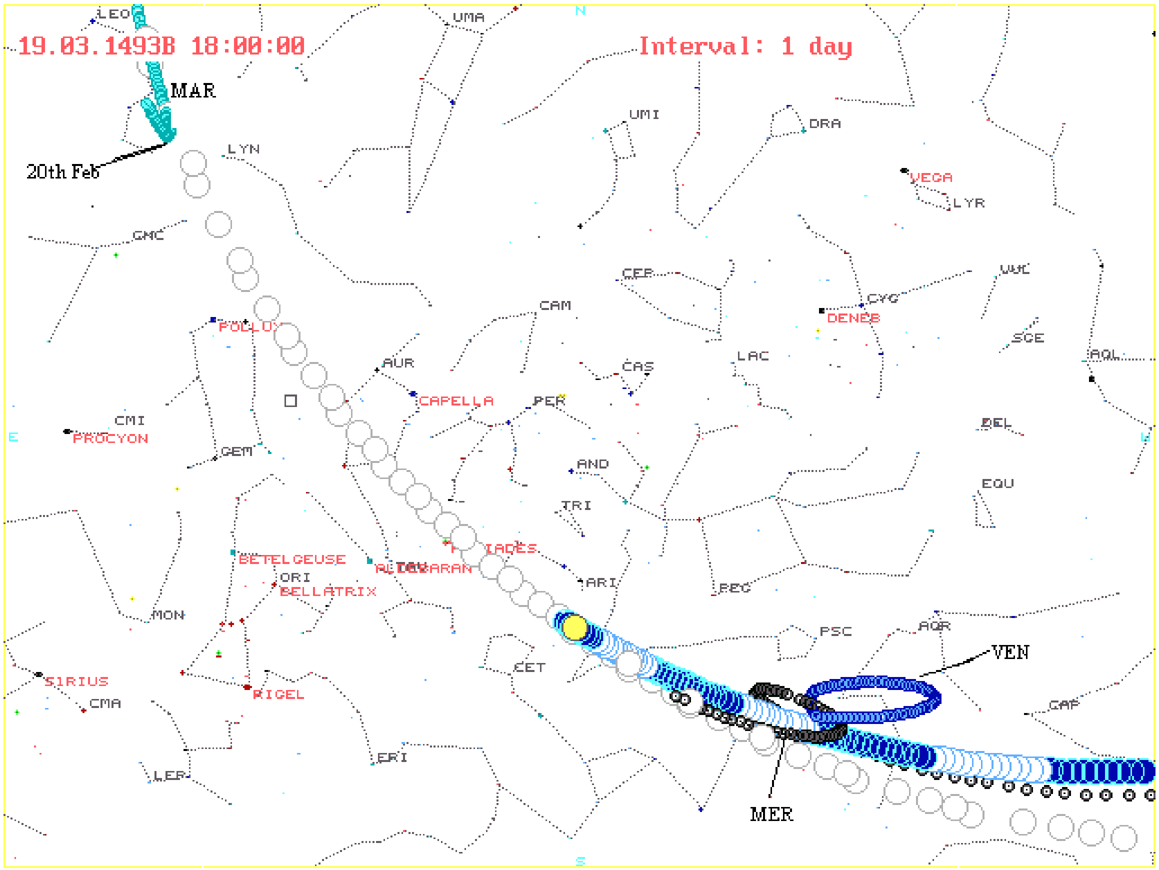


Fig. 4c Retrograde motion of Venus and Mars during 19.12.1494 BC-19.3.1

Notes and References

[1] Thirteen Sanskrit dramas of Bhasa were unearthed and published by Pandit Ganapati Sastri of Trivandrum in 1913. Even though the date of Bhasa is not beyond dispute, based on his style, scholars have placed him around 2nd cent. BC. See "Survey of Sanskrit Literature" by C.Kunhan Raja; Bharatiya Vidya Bhavan, Bombay 1962.

[2] The Mahabharata text brought out by Bhandarkar Oriental Research Institute, is considered a well researched critical edition of the epic. The Machine-readable text of this version was produced by Prof. Muneo Tokunaga, of Kyoto University, Japan with help from several of his Japanese colleagues. The initial version was completed on November 14, 1991. The first revised version (V1) appeared on September 16, 1994. Further upgraded version (1_1) has been available since October 1, 1996.

[3] Pandit Hayagriva Sastri brought out not only Mahabharata but also several other Puranas, sometime during the first half of 19th century. The year of publication of the MB text is not known. However for the Bhagavata Purana, the publication year is mentioned as *indu-muni-sindhu-sasidhara* salivahana saka. This corresponds to 1849 A.D. MB should have been brought out earlier. He mentions in his introduction that he has consulted several manuscripts of the epic, to prepare the print version. He has included at many places the Sanskrit commentary of Nilakantha. He has identified several portions of the text as interpolated, since they were not available in all manuscripts collected by him from Varanasi and other places.

[4] Kisari Mohan Ganguly, was the real translator of Mahabharata into English. This monumental work has been incorrectly attributed to P.C.Roy, who was only a Publisher, in an earlier Calcutta edition. The

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edition of the translation brought out by M/s Munshiram Manoharlal Publishers Pvt. Ltd. of New Delhi, in 1993 corrects this mistake.

[5] Bharata Darsana in Kannada, as the name itself indicates is not a literal translation, although it preserves the original faithfully. The work brought out in 36 volumes is exhaustive and contains critical discussion on the differences among the available versions of the text. Internal inconsistencies in the text are also pointed out in several places. The work closely follows the Gita Press Edition containing the commentary of Nilakantha.

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